

Topic 19: Organic Nitrogen Compounds: Amines, Amides, Amino Acids and Proteins

Students will be assessed on their ability to:

19.1 understand the nomenclature of amides, amines and amino acids and be able to draw their structural, displayed and skeletal formulae

The nitrogen atom has a lone pair and three bonds to one or more alkyl groups
If there is only one alkyl group, it is a primary amine
If there is two, it is secondary
If there is three, it is tertiary

Amines

NAME	DISPLAYED FORMULA	SKELETAL FORMULA
methanamine		
ethanamine		
propanamine		
butanamine		
phenylamine		

Amines are derivatives of ammonia where one or more of the hydrogen atoms is replaced by an organic group (alkyl or aryl)

If the R group is an alkyl group (methyl, ethyl, etc) then it is an *aliphatic amine*

If R is an aryl group (benzene ring or phenyl) then it is an *aromatic amine*

PRIMARY AMINE	SECONDARY AMINE	TERTIARY AMINE

Common name: alkyl + amine

Eg: Propylamine

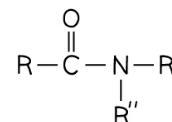
IUPAC name: amino + alkane

Eg: Aminoethane

Amides

NAME	DISPLAYED FORMULA	SKELETAL FORMULA
methanamide		
ethanamide		
propanamide		
butanamide		

Amides are formed from the *condensation reaction of carboxylic acids or acyl chlorides with ammonia or amines*



Have a general structure of RCONR_2

Where R' and R'' are both hydrogen atoms

Primary amide Nitrogen attached to one carbon	Secondary amide Nitrogen attached to two carbons	Tertiary amide Nitrogen attached to three carbons

For primary amides: alkan + amide

Eg: propanamide

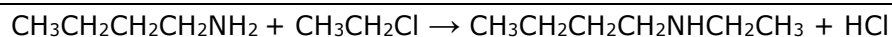
For secondary amides: alkyl chain that is attached to N atom is prefixed with N-

Eg: $\text{CH}_3\text{CONH}(\text{C}_3\text{H}_7) \rightarrow \text{N-propylethanamide}$

For tertiary amides:

Eg: $\text{CH}_3\text{CON}(\text{CH}_3)(\text{C}_3\text{H}_7) \rightarrow \text{N-methyl-N-propylethanamide}$

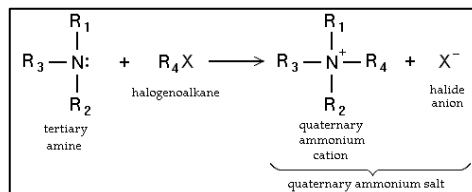
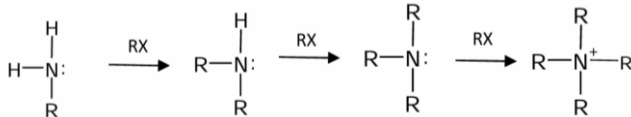
	<p>Amino acids</p> <ul style="list-style-type: none"> - Are organic compounds that contain two functional groups: <ul style="list-style-type: none"> o A basic amino (-NH₂) group o An acidic carboxylic acid (-COOH) group - Are amphoteric due to presence of both a basic and acidic group in amino acids - Hence, can act as both acids and bases - General structural formula of amino acids: <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>R GROUP = ACIDIC</p> $\text{HOOC}-\text{CH}_2-\underset{\text{COOH}}{\overset{\text{NH}_2}{\text{C}}}-\text{H}$ <p>ASPARTIC ACID</p> </div> <div style="text-align: center;"> <p>R GROUP = BASIC</p> $\text{HO}-\text{CH}_2-\underset{\text{COOH}}{\overset{\text{NH}_2}{\text{C}}}-\text{H}$ <p>SERINE</p> </div> <div style="text-align: center;"> <p>R GROUP = NEUTRAL</p> $\text{CH}_3-\underset{\text{COOH}}{\overset{\text{NH}_2}{\text{C}}}-\text{H}$ <p>ALANINE</p> </div> </div> <p style="text-align: center; font-size: small;">Copyright © Save My Exams. All Rights Reserved</p>
19.2	<p>understand the reactions of primary aliphatic amines (using butylamine as an example) and aromatic amines (using phenylamine as an example) with:</p> <ol style="list-style-type: none"> water to form an alkaline solution acids to form salts halogenoalkanes ethanoyl chloride copper(II) ions to form a complex ion
i	<p>Reactions with water</p> <ul style="list-style-type: none"> - To form alkaline solutions Eg: methylamine + water \rightleftharpoons methylammonium ion + hydroxide ion $\text{CH}_3\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{NH}_3^+ + \text{OH}^-$ - Phenylamine is only slightly soluble in water - Reaction does not readily occur with phenylamine because the lone pair on nitrogen is incorporated into the delocalized electrons in the benzene ring which makes it less available to donate the electrons to the hydrogen of water
ii	<p>Reactions with acids to form salts</p> <ul style="list-style-type: none"> - All react with strong acids to form ionic ammonium salts - Eg: butylamine + hydrochloric acid \rightarrow butylammonium chloride - Eg: phenylamine + acid \rightarrow phenylammonium chloride
iii	<p>Reactions with Halogenoalkanes</p> <p>Type: Substitution</p> <p>Mechanism: nucleophilic substitution (shown in 10.9ii)</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> </div> <p>General equation: R'NH₂ + R''X \rightarrow R'NHR'' + HX</p> <ul style="list-style-type: none"> • Eg: phenylamine + chloroethane \rightarrow secondary amine + HCl $\text{C}_6\text{H}_5\text{NH}_2 + \text{CH}_3\text{CH}_2\text{Cl} \rightarrow \text{C}_6\text{H}_5\text{NHCH}_2\text{CH}_3 + \text{HCl}$ • Eg: butylamine + chloroethane \rightarrow secondary amine + HCl



Further reaction

The secondary amine formed still contains an electron-rich N atom so can react with more halogenoalkane to form a tertiary amine which can also react with more halogenoalkane to form a quaternary ammonium salt

Where RX is the haloalkane

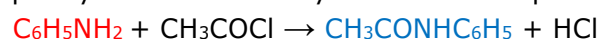


iv

Reactions with Ethanoyl Chloride

Type: Condensation (addition-elimination)

Eg: phenylamine + ethanoyl chloride \rightarrow N-phenylethanamide + HCl



Change in functional gp. from **amine** to **amide**

Conditions: Room temp.

!Acyl chlorides react with primary amines (RNH_2), forming an **N-substituted amide** and hydrogen chloride gas (misty fumes)

v

Reactions with Copper(II) ions

- The lone pair of electrons on the nitrogen *enable amines to act as ligands* and form dative covalent bonds into transition metal ions
- Form coloured complex ions

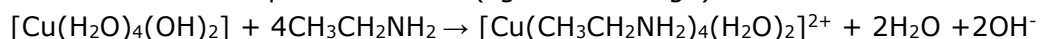
Formation of the pale blue precipitate (deprotonation)



Light blue solution

pale blue precipitate

Formation of the deep blue solution (ligand exchange)



Pale blue precipitate

Deep blue solution

!These are similar reactions to those where ammonia acts as the ligand in 17.22

19.3	understand that amines are miscible with water as a result of hydrogen bonding, and the reasons for the difference in basicity between ammonia, primary aliphatic amines and primary aromatic amines
	<p>Solubility of Amines</p> <ul style="list-style-type: none"> - The first few members of the homologous series of primary aliphatic amines are miscible with water - But, <i>as the hydrocarbon part of the molecule increases, the solubility decreases</i> - They can dissolve in water as <i>the N atom can use its lone pair to form a dative bond with the H atom of water</i> (i.e. they can form hydrogen bonds with water) - Phenylamine is only slightly soluble in water <p>Basicity of Amines</p> <ul style="list-style-type: none"> - Primary aliphatic amines act as Bronsted-Lowry bases because the lone pair of electrons on the N atom is readily available for forming a dative covalent bond with a H⁺ ion and so they can accept a proton - Factors that may affect the basicity of amines include: <ol style="list-style-type: none"> 1. Positive inductive effect 2. Delocalisation <div> <div> <p>Secondary amines are stronger bases than primary amines because they have more alkyl groups which result in more electron density being pushed onto the N atom, causing more positive inductive effect (as the inductive effect of alkyl groups is greater than that of H atoms)</p> </div> <div> <p>Primary aliphatic amines are stronger bases than ammonia as there is greater electron density on the nitrogen atom. This is due to the alkyl groups being electron-releasing and pushing electrons towards the nitrogen atom (positive inductive effect)</p> </div> <div> <p>Ammonia does not have electron-donating groups to cause positive inductive effect, but it does not have aromatic rings to cause delocalization of nitrogen's lone pair either</p> </div> <div> <p>Primary aromatic amines such as phenylamine do not form basic solutions because the lone pair of electrons on the nitrogen is delocalised in the benzene ring and so is less able to accept protons (and form dative bond with H⁺)</p> </div> </div> <div> </div>

19.4	<p>understand, in terms of reagents and general reaction conditions, the preparation of primary aliphatic amines:</p> <ol style="list-style-type: none"> from halogenoalkanes by the reduction of nitriles
i	<p>Preparation from Halogenoalkanes</p> <p>Nucleophile: NH₃ Mechanism: nucleophilic substitution (shown in 10.9ii)</p> $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + 2\text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Br}$ <p>Change in functional gp. Primary Halogenoalkane → Primary Amine</p> <p>Reagents: excess NH₃ in ethanol Conditions: ethanolic, heat under pressure in a sealed tube</p> <p>Further substitution reactions can occur between the halogenoalkane and the amines formed leading to a lower yield of the amine (secondary amines can form)</p>

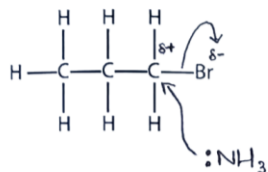
To produce a high yield of primary amine, ammonia is used in excess which limits further reactions

ii

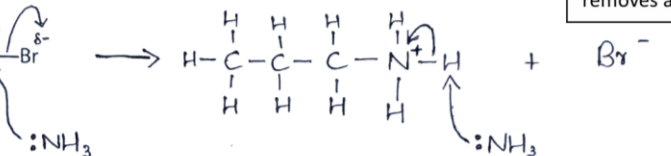
A primary halogenoalkane reacts with ammonia to form a primary amine
Mechanism is as follows:

Another NH₃ acts as a base and removes a proton

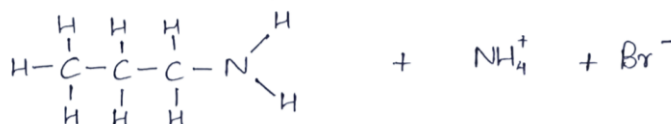
Lone pair on ammonia attacks partially positive carbon



C-X bond breaks heterolytically



N-H bond breaks heterolytically

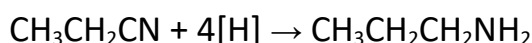


ii

Preparation from Nitriles

Type: Reduction

Reducing Agent: LiAlH₄ in dry ether (OR with H₂ and Ni catalyst)

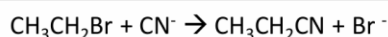


Change in functional gp. **Nitriles** **Primary Amine**

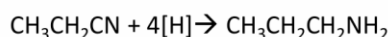
Conditions: in dry ether (to ensure no water is present)

!Usually followed by hydrolysis with dilute acid

Step 1. convert **halogenoalkane to nitrile** by using KCN in aqueous ethanol (heat under reflux)



Step 2. reduce **nitrile to amine** by using LiAlH₄ in ether or by reducing with H₂ using a Ni catalyst



Adv: More efficient than reaction i as it does not form further substitution reactions

Disadv: It is a two-step reaction so may have a low yield + KCN is toxic

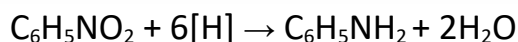
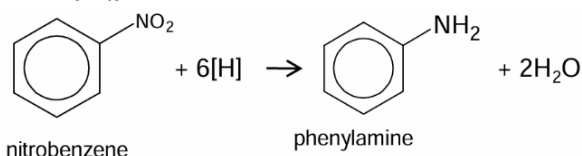
19.5

know the **preparation of aromatic amines** by the reduction of aromatic nitro-compounds using tin and concentrated hydrochloric acid

Preparation of Aromatic Amines (Phenylamine)

Type: Reduction (of nitrobenzene)

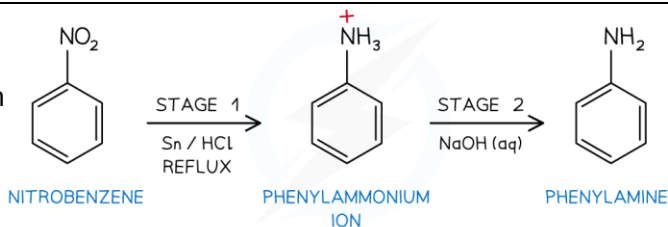
Reducing Agent: Sn (Tin) & HCl(aq)



Change in functional gp. **Benzene** **Aromatic Amine**

Conditions: mixed in conc. HCl(aq) and heat under reflux

Phenylamine is basic so will react with the acid to form phenylammonium ion which can be converted into phenylamine by adding an alkali like NaOH



Purification of Phenylamine

- The crude phenylamine product undergoes steam distillation to produce a cloudy distillate
- Sodium chloride is added to the distillate before the mixture is added to a separating funnel
- Ether is added to the separating funnel resulting in an aqueous layer at the bottom and an organic layer, containing the phenylamine, on the top
 - o The sodium chloride aids separation by increasing the polarity of the aqueous layer causing the phenylamine to "salt out" into the organic layer
- The aqueous layer is discarded and the organic layer is distilled
 - o The ether will boil off easily and is discarded
 - o The phenylamine fraction that boils off at 180-185°C is retained and can have its boiling point tested to check the purity of the product

19.6

be able to describe the reaction of aromatic amines with nitrous acid to form benzenediazonium ions, followed by a coupling reaction with phenol to form a dye

Reaction of Aromatic Amines

Formation of Azo Dyes

- Azo (or diazonium) compounds are organic compounds that have an $R_1-N=N-R_2$ group
- They are often used as dyes, pigments and colourings and are formed in a coupling reaction between the diazonium ion and an alkaline solution of phenol

Coupling of benzenediazonium chloride with phenol in NaOH

Step 1: Formation of Nitrous acid

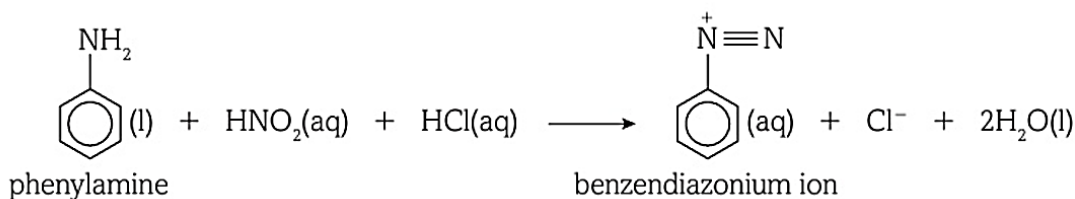


NITROUS ACID

HNO₂ is made in situ from NaNO₂/HCl

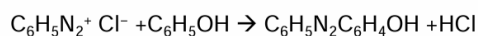
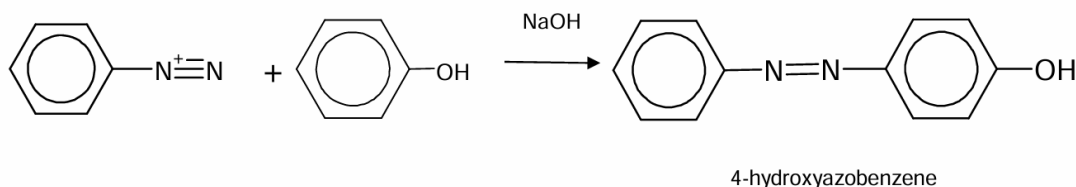
Step 2: Reaction of Phenylamine with Nitrous Acid forming Diazonium ions

Condition: Dilute acid and Temperature should be between 0 and 10°C using ice



Step 3: Reaction of Diazonium ions with Phenols forming Azo Dyes

Condition: alkaline conditions (NaOH)



If temp is above 10°C, the diazonium ion will decompose to form phenol and nitrogen
If temp is below 0°C, reaction would be too slow

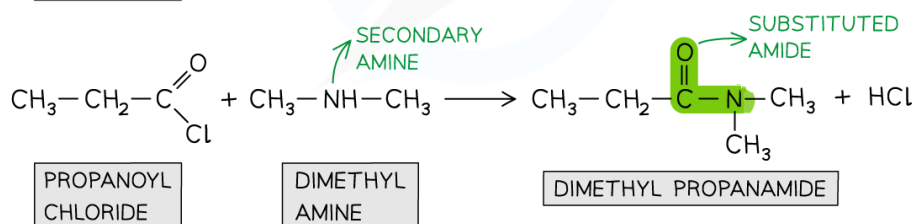
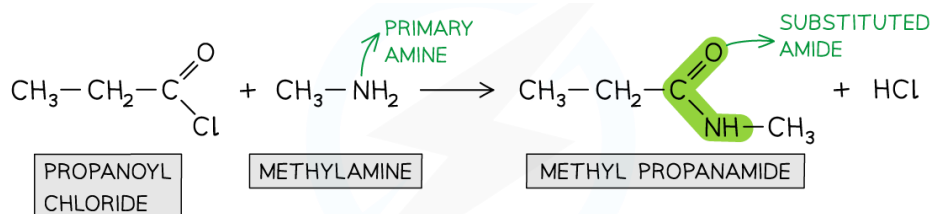
Formation of Amides from acyl chlorides

Type: Condensation reaction (nucleophilic addition-elimination)

Condition: Room temp.

Amides can be prepared from the condensation reaction between an acyl chloride and ammonia or amine

1. Acyl chlorides react with primary amines (RNH_2), forming a **N-substituted amide** and hydrogen chloride gas (misty fumes)
2. Acyl chlorides react with secondary amines (R_2NH), forming a **N,N-disubstituted amide** and hydrogen chloride gas (misty fumes)
3. Acyl chlorides react with ammonia (NH_3), forming a **non-substituted amide**

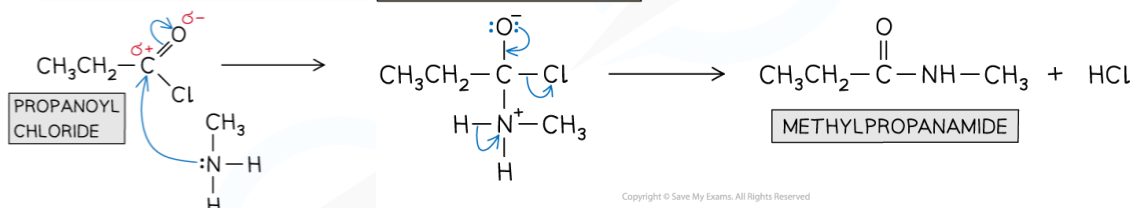


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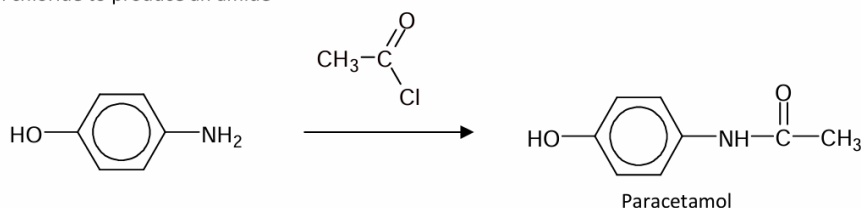
**Addition-Elimination Mechanism (You may not need to know)**

STEP 1: NUCLEOPHILIC ADDITION

STEP 2: ELIMINATION

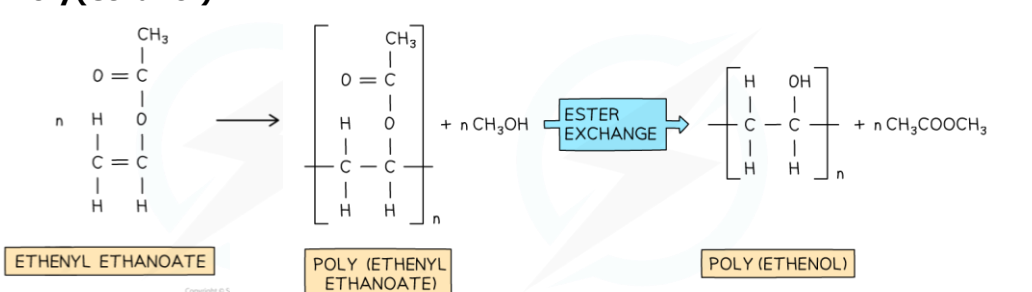


Paracetamol is made by the reaction of an aromatic amine with an acyl chloride to produce an amide



19.8	be able to describe: <ul style="list-style-type: none"> i condensation polymerisation for the formation of polyamides such as nylon and proteins ii addition polymerisation, including poly(propenamide) and poly(ethenol)
i	<p>Condensation polymerization</p> <ul style="list-style-type: none"> - Condensation polymerisation has been covered in 15.16 - Defined as "a reaction where two different monomers join together to form a long chain polymer with the elimination of a small molecule (usually water or hydrogen chloride)" - Most common types of condensation polymers are polyesters and polyamides which involve the formation of an ester or an amide linkage - Condensation polymers can be formed by: <ul style="list-style-type: none"> Dicarboxylic acids and diols Dicarboxylic acids and diamines Amino acids <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Polyesters</p> <ul style="list-style-type: none"> - Has been covered in 15.16 - Has an ester linkage (-COO-) - Formed by the reaction between dicarboxylic acid and diol monomers - Can also be formed by hydroxycarboxylic acids monomers (contain an -OH group at one end while the other has a -COOH group) <div style="text-align: center; margin-top: 10px;"> $\text{HO}-(\text{CH}_2)_3-\overset{\text{O}}{\underset{\text{Cl}}{\text{C}}} \longrightarrow \text{---O---}(\text{CH}_2)_3-\overset{\text{O}}{\text{C}}\text{---O---}(\text{CH}_2)_3-\overset{\text{O}}{\text{C}}\text{---O---}(\text{CH}_2)_3-\overset{\text{O}}{\text{C}}\text{---}$ <p>3 repeating units</p> </div> </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Polyamides</p> <ul style="list-style-type: none"> - Has an amide linkage (-CONH-) - Formed by reaction between diacyl dichlorides and diamine - Formed by reaction between dicarboxylic acid and diamine <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Kevlar- a common polyamide</p> $n \text{ HO}_2\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{H} + n \text{ H}_2\text{N}-\text{C}_6\text{H}_4-\text{NH}_2 \longrightarrow \left[\text{NH}-\text{C}_6\text{H}_4-\text{NH}-\text{C}(=\text{O})-\text{C}_6\text{H}_4-\text{C}(=\text{O}) \right]_n + 2n-1 \text{ H}_2\text{O}$ </div> <p>Kevlar is a strong and flexible polymer material with fire resistance properties</p> </div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Amino Acids</p> <ul style="list-style-type: none"> - Proteins are basically polymers made up of amino acid monomers - Amino acids have an aminocarboxylic acid structure - Their properties are governed by a branching side group - the R group <div style="display: flex; justify-content: space-around; align-items: flex-start; margin-top: 10px;"> <div style="text-align: center;"> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">AMINO GROUP</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">CARBOXYL GROUP</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> $\begin{array}{c} \text{H} & \text{H} & \text{O} \\ & & \\ \text{H}-\text{N}-\text{C}-\text{C}-\text{OH} \\ \\ \text{R} \end{array}$ </div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">SIDE CHAIN</div> <div style="border: 1px solid black; padding: 5px; margin-top: 10px; font-size: small;"> THE R SIDE CHAIN IS DIFFERENT FOR EACH AMINO ACID. THE 20 NATURALLY OCCURRING AMINO ACIDS HAVE UNIQUE R GROUPS </div> </div> <div style="text-align: center;"> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px; font-size: small;">2 AMINO ACIDS REACT TOGETHER TO FORM A DIPEPTIDE</div> <div style="margin-bottom: 10px;"> $\text{H}_2\text{N}-\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{COOH} + \text{H}_2\text{N}-\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{COOH}$ </div> <div style="margin-bottom: 10px;"> $\downarrow -\text{H}_2\text{O}$ </div> <div style="margin-bottom: 10px;"> $\text{H}_2\text{N}-\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\overset{\text{O}}{\underset{\text{H}}{\text{C}}}-\overset{\text{H}}{\underset{\text{R}}{\text{N}}}-\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{COOH}$ </div> <div style="border: 1px solid black; padding: 2px; font-size: small;">AMIDE/PEPTIDE LINK IN THE DIPEPTIDE</div> </div> </div> </div>

ii	<p>Addition polymerization</p> <ul style="list-style-type: none"> - Addition polymerisation has been covered in 5.7 - Defined as "a reaction where small chain monomers are converted into long chain polymers without the elimination of any small atoms or molecules" - They are formed using unsaturated monomers (they have C=C bonds) joined together to form polymers such as poly(alkenes) - Poly(alkenes) are chemically inert due to the strong C-C and C-H bonds and non-polar nature of the bonds which makes them non-biodegradable <div data-bbox="450 443 1340 792"> <p>It is best to first draw out the monomer with groups of atoms arranged around the double bond</p> <p>e.g. For propenamide</p> $\text{H}_2\text{C}=\text{CH}-\text{C}(=\text{O})\text{NH}_2 \longrightarrow \begin{array}{c} \text{H} & \text{O} \\ & \\ \text{C} & -\text{C}-\text{NH}_2 \\ & \\ \text{H} & \text{H} \end{array} \longrightarrow \left[\begin{array}{c} \text{H} & \text{O} \\ & \\ -\text{C} & -\text{C}- \\ & \\ \text{H} & \text{H} \end{array} \right]_n$ <p>poly(propenamide)</p> <p>Poly(ethenol)</p> $n \begin{array}{c} \text{H} & \text{OH} \\ & \\ \text{C} & =\text{C} \\ & \\ \text{H} & \text{H} \end{array} \longrightarrow \left[\begin{array}{c} \text{H} & \text{OH} \\ & \\ -\text{C} & -\text{C}- \\ & \\ \text{H} & \text{H} \end{array} \right]_n$ <p>poly(ethenol)</p> <p>The addition polymer poly(ethenol) has good solubility in water because it can form many strong hydrogen bonds with water. This makes it a useful polymer for uses such as soluble laundry bags and liquid detergent capsules (Liquitabs).</p> </div>
19.9	be able to draw the structural formulae of the repeat units of the polymers in 19.8
i	<p>Condensation Polymers</p> <p>Nylon</p> <p>Nylon 6,6 - a common polyamide</p> <div data-bbox="331 936 1460 1182"> $n \begin{array}{c} \text{O} & & \text{O} \\ & & \\ \text{HO}-\text{C} & -(\text{CH}_2)_4- & \text{C}-\text{OH} \\ \text{hexanedioic acid} \end{array} + n \begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{H}-\text{N} & -(\text{CH}_2)_6- & \text{N}-\text{H} \\ \text{Hexane-1,6-diamine} \end{array} \longrightarrow \left[\begin{array}{c} \text{O} & & \text{O} \\ & & \\ -\text{C} & -(\text{CH}_2)_4- & \text{C}-\text{N} & -(\text{CH}_2)_6- & \text{N}- \\ & & & & \\ \text{H} & & \text{H} & & \text{H} \end{array} \right]_n + 2n-1 \text{H}_2\text{O}$ <p>The 6,6 stands for 6 carbons in each of the monomers. Different length carbon chains produce different polyamides</p> </div> <p>Proteins</p>
ii	Addition Polymers

	<p>Poly(propenamide)</p> <p>It is best to first draw out the monomer with groups of atoms arranged around the double bond</p> <p>e.g. For propenamide</p> $\text{H}_2\text{C}=\text{CH}-\text{C}(=\text{O})\text{NH}_2 \longrightarrow \begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C}-\text{NH}_2 \\ \\ \text{C}=\text{C} \\ \quad \\ \text{H} \quad \text{H} \end{array} \longrightarrow \left[\begin{array}{cc} \text{H} & \text{O} \\ & \parallel \\ -\text{C} & -\text{C}-\text{NH}_2 \\ & \\ \text{H} & \text{H} \end{array} \right]_n$ <p style="text-align: center;">poly(propenamide)</p>
	<p>Poly(ethanol)</p> <p>  </p> <p> ETHENYL ETHANOATE POLY (ETHENYL ETHANOATE) POLY (ETHANOL) </p> <p>The addition polymer poly(ethanol) has good solubility in water because it can form many strong hydrogen bonds with water</p> <p>This makes it a useful polymer for uses such as soluble laundry bags and liquid detergent capsules (liquitabs)</p>
<p>19.10</p>	<p>be able to comment on the physical properties of polyamides and the solubility in water of the addition polymer poly(ethanol) in terms of hydrogen bonding, including soluble laundry bags or liquid-detergent capsules (liquitabs)</p>
	<p>Properties of polyamides</p> <ul style="list-style-type: none"> • Most polyamides (nylons) tend to be semi-crystalline • They are generally very tough with good thermal and chemical resistance • Polyamides tend to absorb moisture from their surroundings <ul style="list-style-type: none"> ○ This absorption increases until equilibrium is reached • The impact resistance and flexibility of polyamides increases with water content whilst strength and stiffness decrease • The strong bonds in polyamides make the polyamide chains strong allowing them to be made into strong fibres for clothing <ul style="list-style-type: none"> ○ E.g. Kevlar shown above • Polyamide film (cling film) is used in food packaging due to its toughness and the fact it prevents gas molecules from passing through • Polyamide film is also used for 'Boil in the bag' foods due to its high-temperature resistance
<p>19.11</p>	<p>be able to describe experiments to investigate the characteristic behaviour of amino acids limited to:</p> <ol style="list-style-type: none"> acidity and basicity and the formation of zwitterions effect of aqueous solutions on plane-polarised monochromatic light formation of peptide bonds by condensation polymerisation
<p>i</p>	<p>Acidity and basicity</p> <ul style="list-style-type: none"> - The amine group is basic (so will react with acids) and the carboxylic acid group is acidic (so will react with bases) - However, they can also interact intramolecularly (within themselves) to form a zwitterion

	<ul style="list-style-type: none"> - A zwitterion is an ion with both a positive (-NH_3^+) and a negative (-COO^-) charge - Because of these charges in a zwitterion, there are strong intermolecular forces of attraction between amino acids <ul style="list-style-type: none"> o Amino acids are therefore soluble crystalline solids <p>Formation of zwitterions (isoelectric point)</p> <ul style="list-style-type: none"> - Amino acids act as weak buffers and will only gradually change pH if small amounts of acid or alkali are added to the amino acids <p>Lysine is a zwitterion as a solid</p>
ii	<p>Optical Activity</p> <p>All amino acids, except glycine, are chiral because there are four different groups around the C atom</p> <p>Aqueous solutions of the enantiomers rotate plane-polarised light</p> <p>If an amino acid is synthesised in the lab, a racemic mixture is formed</p>
iii	<p>Formation of peptide bonds (by condensation polymerization)</p>
19.12	<p>CORE PRACTICAL 15</p> <p>Analysis of some inorganic and organic unknowns.</p>
	<p>Further suggested practicals:</p> <ul style="list-style-type: none"> i carry out some of the reactions of amines from 19.2 i, ii and v ii prepare an azo dye from 19.6 iii carry out reactions of amino acids from 19.11 i iv prepare nylon-6.6 or 6.10 from 19.8